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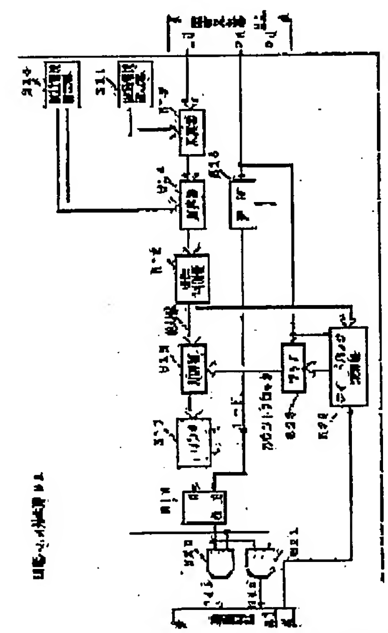
(54) FLOW CONTROL DEVICE OF MOLTEN METAL

(57)Abstract:
PURPOSE: To suppress the inclusion of the powder by providing a DC energizing means to energize the AC current for linear driving to an electric coil and a DC energizing means to energize the DC current for braking to an electric coil, and thereby making the molten steel flow along the wall surface of a die.
CONSTITUTION: In a flow control device of the molten metal, a plurality of AC energizing means 81-611, 612, 615-621 supply the AC current for linear driving to flow the molten metal in the direction of arraying status of the magnetic poles to a plurality of electric coils to excite each of a plurality of magnetic poles to be arranged along the side of the dies surrounding the molten metal. At the same time, the DC current energizing means 81-, 611, 612, 615-621 supply the DC current for braking to brake the molten metal. The molten metal flows in the direction of the arraying status of the magnetic poles by the AC current of the electric coils while it is braked by the DC current. The same electric coils are commonly used both for flowing and for braking, and the flow of the molten steel is promoted, and blow holes in the solidified surface of the molten steel are removed.



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CLAIMS

[Claim(s)]

[Claim 1] Two or more electric coils for exciting two or more magnetic poles of magnetic pole; each arranged along the mold side which encloses molten metal; the flow control unit of molten metal equipped with direct-current energization means; which energizes a direct current for braking for braking alternating current energization means; which energizes the alternating current for a linear drive for carrying out the flow drive of said molten metal to said electric coil, and molten metal to said electric coil in the array direction of said magnetic pole.

[Claim 2] two or more electric coil; for exciting two or more magnetic poles of magnetic pole; each arranged along the mold side which encloses molten metal — driving force setting means [for defining the linear driving force of each electric coil]; — damping force setting means [for defining the damping force of each electric coil]; — to each electric coil Energize the alternating current for generating the linear driving force which said driving force setting means defined. The flow control unit of molten metal equipped with two or more direct-current energization means; which energizes a direct current for generating two or more alternating current energization means; and the damping force which said damping force setting means set to each electric coil.

[Claim 3] m>=3 arranged along the mold side which encloses molten metal, and n>=1, the 1st and 2nd ... the — mxn magnetic pole; — for exciting each of these magnetic poles the 1st and 2nd ... the — a signal generation means to generate the signal of m ream for forming a mxn electric coil; linear drive alternating current wave; the signal of the 1st ream — the 1st, m+1, 2m+1, and ... the output signal of a magnification means to amplify with the amplification factor addressed to each electric coil, and a magnification means The means which was addressed to each of these electric coils and which carries out bias value part bias, It reaches. the 1st energized to each electric coil by the energization duty corresponding to the signal by which bias was carried out, m+1, 2m+1, and ... coil driver; — the signal of the 2nd ream — the 2nd, m+2, 2m+2, and ... the output signal of a magnification means to amplify with the amplification factor addressed to each electric coil, and a magnification means The means which was addressed to each of these electric coils and which carries out bias value part bias, It reaches. the 2nd energized to each electric coil by the energization duty corresponding to the signal by which bias was carried out, m+2, 2m+2, and ... coil driver; — the signal of the m-th ream — the m-th, 2m, 3m, and ... the output signal of a magnification means to amplify with the amplification factor addressed to each electric coil, and a magnification means the m-th energized to each electric coil by the energization duty corresponding to the means which was addressed to each of these electric coils, and which carries out bias value part bias, and the signal by which bias was carried out, 2m, 3m, and ... the flow control unit of molten metal equipped with coil driver;.

[Claim 4] m>=3 arranged along the mold side which encloses molten metal, and n>=1, the 1st and 2nd ... the — mxn magnetic pole; — for exciting each of these magnetic poles Renewal of sequential of the read-out address of this memory means is carried out the memory means; predetermined period Tpa which stored energization due teddy-TA for forming a mxn electric coil; alternating current wave. the 1st and 2nd ... the — It is related with said alternating current wave. Predetermined phase [every] ******, Energization due teddy-TA of m ream means; to read — energization due teddy-TA of the 1st read ream — the 1st, m+1, 2m+1, and ... in the multiplication means which carries out the multiplication of the amplification factor addressed to each electric coil, an addition means to apply the bias value addressed to the obtained product by each of these electric coils, and the predetermined period Tpa the 1st energized to each of these electric coils between the time amount which the sum which this addition means obtained shows, m+1, 2m+1, and .... energization due teddy-TA of the 2nd ream coil driver; read — the 2nd, m+2, 2m+2, and ... the amplification factor addressed to each electric coil The inside of the multiplication means which carries out multiplication, an addition means to apply the bias value addressed to the obtained product by each of these electric coils, and the predetermined period Tpa, the 2nd which these electric coils boil between the time amount which the sum which this addition means obtained shows, respectively, and is energized, m+2, 2m+2, and ... energization due teddy-TA of the m-th ream coil driver; read — the m-th, 2m, 3m, and ... the amplification factor addressed to each electric coil The inside of the multiplication means which carries out multiplication, an addition means to apply the bias value addressed to the obtained product by each of these electric coils, and the predetermined period Tpa, the m-th energized to each of these electric coils between the time amount which the sum which this addition means obtained shows, 2m, 3m, and ... the flow control unit of molten metal equipped with coil driver;.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] Although this invention is not the intention especially restricted to this about the flow driving gear for agitating the molten metal in mold, it relates to the flow control unit which carries out a flow drive horizontally along the mold side, and brakes the molten metal in continuous casting mold in the place where the rate of flow is large.
[0002]
[Description of the Prior Art] For example, in continuous casting, molten steel is poured into mold from tundish, and it is drawn out; molten steel being gradually cooled from a mold wall surface in mold. It is easy to produce a surface check and shell fracture as the temperature in the mold wall surface of the same height is uneven. In order to improve this, conventionally, an electromagnet or a linear motor is used and the circulation drive of the molten steel is carried out along with a mold wall surface at the top face and parallel within mold (for example, JP,1-228645,A). Moreover, although the powder on molten steel is involved in into molten steel as the molten steel drift velocity in the molten steel surface section is uneven, and this serves as a defect in slab, molten steel is supplied to mold through an impregnation nozzle from tundish, and the rate at which this molten steel flows into mold is high, and, thereby, tends to produce powder entrainment. JP,3-258442,A is shown the electromagnetic-brake equipment which adds a static magnetic field to molten steel in order to improve this.
[0003]
[Problem(s) to be Solved by the Invention] Although the flow drive of the molten steel of presentation to JP,1-228645,A has a certain amount of effectiveness, the circulation which met the mold wall surface by the flow of the molten steel which flows into tundish through an impregnation nozzle is disturbed. Although the electromagnetic-brake equipment of presentation to JP,3-258442,A has the effectiveness which controls the flow of the molten steel which flows into tundish through an impregnation nozzle, the effectiveness which equalizes a velocity distribution is low.
[0004] This invention is [0005] aiming at carrying out the flow drive of the molten metal, and equalizing the rate of flow more.
[Means for Solving the Problem] The flow control unit of the molten metal of this invention Molten metal The mold side to surround Two or more magnetic poles arranged along with (1) (11-19); each magnetic pole Two or more electric coils for exciting ; (1Aa-3Aa, 1Ba-3Ba, 1calcium - 3calcium) An alternating current energization means to energize the alternating current for a linear drive for carrying out the flow drive of said molten metal (Iaa:Aa, Ba, calcium) to said electric coil in the array direction of said magnetic pole (61-83;61-69) It has direct-current energization means (613,614,615-621;41-49 of 61-69); which energizes a direct current for braking for braking 611,612,615-621;41-49; and molten metal (Ib) to said electric coil.
[0006] This invention 1 operative condition a flow control unit [like] Molten metal The mold side to surround Two or more magnetic poles arranged along with (1) (11-19); each magnetic pole two or more electric coil (1Aa-3Aa, 1Ba-3Ba, 1calcium - 3calcium); for exciting -- driving force setting means [for defining the linear driving force of each electric coil] (611,612 of 61-69); -- the damping force of each electric coil The damping force setting means for setting (613,614 of 61-69); to each electric coil Energize the alternating current (Iaa:Aa, Ba, calcium) for generating the linear driving force which said driving force setting means defined. two or more alternating current energization means (615-621;41-49 of 81-83;61-69); -- and It has two or more direct-current energization means (615-621;41-49 of 61-69); which energizes a direct current (Ib) for generating the damping force which said damping force setting means set to each electric coil.
[0007] The flow control unit of the more concrete embodiment of this invention m>=3 arranged along the mold side (1) which encloses molten metal, and n>=1, the 1st and 2nd ... the -- mxn magnetic pole (11-19); -- for exciting each of these magnetic poles the 1st and 2nd ... the -- a mxn electric coil A signal generation means to generate the signal of m ream for forming linear drive alternating current wave (Aa, Ba, calcium) (61-83); (1Aa, 1Ba, 1calcium, 2Aa, 2Ba, 2calcium, 3Aa, 3Ba, 3calcium) The signal (Aa correspondence) of the 1st ream the 1st, m+1, 2m+1, and ... an electric coil (1Aa, 2Aa, 3Aa) -- a magnification means (612) to amplify with the amplification factor (611 outputs) which was alike, respectively and was addressed -- The means which was addressed to each of these electric coils in the output signal of a magnification means (612) and which carries out bias value (613 outputs) part bias (614), It reaches. the 1st energized to each electric coil by the energization duty corresponding to the signal by which bias was carried out, m+1, 2m+1, and ... coil driver (615 to 621; 41 of 61, 64, and 67, 411-414 of 44 and 47); -- the signal (Ba correspondence) of the 2nd ream the 2nd, m+2, 2m+2, and ... an electric coil (1Ba, 2Ba, 3Ba) -- a magnification means to amplify with the amplification factor which was alike, respectively and was addressed, and the means which was addressed to each of these electric coils in the output signal of a magnification means and which carries out bias value part bias -- It reaches. the 2nd energized to each electric coil by the energization duty corresponding to the signal by which bias was carried out, m+2, 2m+2, and ... coil driver (615 to 621; 42 of 62, 65, and 68, 411-414 of 45 and 48); -- the signal (calcium correspondence) of the 3rd ream the m-th, 2m, 3m, and ... an electric coil (1calcium, 2calcium, 3calcium) -- a magnification means to amplify with the amplification factor which was alike, respectively and was addressed, and the means which was

addressed to each of these electric coils in the output signal of a magnification means and which carries out bias value part bias — and the m-th energized to each electric coil by the energization duty corresponding to the signal by which bias was carried out, 2m, 3m, and ... it has coil driver (615 to 621; 43 of 63, 66, and 69, 411-414 of 46 and 49);.

[0008] the 1st and 2nd ... which arranged one example of this invention along the mold side (1) which encloses molten metal — the — mxn magnetic pole (11-19); — for exciting each of these magnetic poles the 1st and 2nd ... the — a mxn electric coil (1Aa, 1Ba, 1calcium, 2Aa, 2Ba, 2calcium, 3Aa, 3Ba, 3calcium); alternating current wave — memory means (812 of 81-83); which stored energization due teddy-TA for forming (Aa) — this memory means the predetermined period Tpa Renewal of sequential of the read-out address of (812 of 81-83) is carried out, and it is related with said alternating current wave (Aa). Predetermined phase [every] ******, means; which reads energization due teddy-TA of m ream (three reams: every Aa, Ba, calcium correspondence) — energization due teddy-TA of the 1st read ream (Aa correspondence) — the 1st, m+1, 2m+1, and ... an electric coil (1Aa, 2Aa, 3Aa) — the amplification factor which was alike, respectively and was addressed The multiplication means (612 of 61, 64, and 67) which carries out multiplication, an addition means to apply the bias value addressed to the obtained product by each of these electric coils (614 of 61, 64, and 67), The inside of the predetermined period Tpa, the 1st energized to each of these electric coils between the time amount which the sum which this addition means obtained shows, m+1, 2m+1, and ... energization due teddy-TA of the 2nd ream (Ba correspondence) coil driver (617 to 621; 41 of 61, 64, and 67, 411-414 of 44 and 47); read — the 2nd — m+2, 2m+2, and ... an electric coil (1Ba, 2Ba, 3Ba) — the multiplication means (612 of 62, 65, and 68) which carries out the multiplication of the amplification factor which was alike, respectively and was addressed — An addition means to apply the bias value addressed to the obtained product by each of these electric coils (614 of 62, 65, and 68), The inside of the predetermined period Tpa, the 2nd which these electric coils boil between the time amount which the sum which this addition means obtained shows, respectively, and is energized, m+2, 2m+2, and ... it was coil driver (617 to 621; 42 of 62, 65, and 68, 411-414 of 45 and 48); read — the m-th ream energization due teddy-TA (corresponding to calcium) — the m-th, 2m, 3m, and ... an electric coil (1calcium, 2calcium, 3calcium) — the multiplication means (612 of 63, 66, and 69) which carries out the multiplication of the amplification factor which was alike, respectively and was addressed — An addition means to apply the bias value addressed to the obtained product by each of these electric coils (614 of 63, 66, and 69), the m-th energized to each of these electric coils between the time amount which the sum which this addition means in the predetermined period Tpa obtained shows, 2m, 3m, and ... it has coil driver (617 to 621; 43 of 63, 66, and 69, 411-414 of 46 and 49);.

[0009] In addition, the notation shown in the above-mentioned parenthesis shows the sign or correspondence matter of an element of corresponding in the example mentioned later, by reference.

[0010]

[Function] To two or more electric coils (1Aa-3Aa, 1Ba-3Ba, 1calcium - 3calcium) for exciting each of two or more magnetic poles (11-19) arranged in the flow control unit of the molten metal of this invention along the mold side (1) which encloses molten metal An alternating current energization means (611,612,615-621;41-49 of 81-83;61-69) The alternating current for a linear drive for carrying out the flow drive of the molten metal (Iaa;Aa, Ba, calcium) is energized in the array direction of a magnetic pole. And a direct-current energization means (613,614,615-621;41-49 of 61-69) energizes a direct current for braking for braking molten metal (Ib). The flow drive of the molten metal is carried out by alternating current energization of an electric coil in the array direction of a magnetic pole, and the galvanization brakes. That is, the same electric coil is shared by a flow drive and braking. Therefore, flow of molten steel is ******(ed) by this flow drive, the blowhole of a molten steel coagulation front face can be removed, moreover, the rate of flow of impregnation molten steel can be controlled by braking, and surfacing of inclusion (for example, powder) can be made easy. Thus, the same electric coil can perform flow drive for control of a blowhole, or removal, and braking for control of the contamination of inclusion, and promotion of surfacing.

[0011] In said embodiment of this invention, a driving force setting means (611,612 of 61-69) defines the linear driving force of each electric coil. A damping force setting means (613,614 of 61-69) defines the damping force of each electric coil. Two or more alternating current energization means (615-621;41-49 of 81-83;61-69) to each electric coil The alternating current (Iaa;Aa, Ba, calcium) for generating the linear driving force which said driving force setting means defined is energized. And a direct current (Ib) for two or more direct-current energization means (615-621;41-49 of 61-69) to generate the damping force which said damping force setting means set to each electric coil is energized. That is, the alternating current and a direct current for generating the flow driving force and damping force which were addressed to it for every one electric coil are passed. For example, as shown in <u>drawing 1</u> , when there is a nozzle 30 for molten steel impregnation at the core of the rectangle space surrounded in the mold sides 1-4, molten steel flows within mold in the direction shown in (a) of <u>drawing 8</u> by the continuous-line arrow head by the profile, in the horizontal direction of a long side 1, it is uneven and it is [a molten steel style has the too quick rate of flow in the nozzle 30 latest, and] late at the distant place. In this case, by passing the alternating current and the direct current which generate the flow driving force strong against an electric coil and the weak damping force of the nozzle latest, the blowhole of a molten steel coagulation front face is removed, and that generating is controlled. The depressor effect of a blowhole and the surfacing facilitatory effect of inclusion are brought to coincidence over the horizontal overall length of a long side 1 by setting up each linear driving force and damping force of an electric coil with the driving force setting means (611,612 of 61-69), and the damping force setting means (613,614 of 61-69), so that the rate of flow of the molten steel in the horizontal direction of a long side 1 may become in homogeneity and the same direction.

[0012] In said one example of this invention, <u>each electric coil is linear motor energization (for a flow drive) by m phase (example m= 3) alternating current,</u> and in order to add the direct current for braking to this, an electric coil energization current value is determined by energization duty control. The change of a time series change of energization duty and an energization polarity is also hung down. [wave / alternating current] The alternating current wave form of the amplitude corresponding to necessary flow driving force is obtained by carrying out the multiplication of the amplification factor to a series of energization duty which brings about a basic alternating current wave form. A multiplication means performs such amplitude adjustment or a setup by each electric coil correspondence. An in one direction flowed part for braking is superimposed on an alternating current wave by each electric coil correspondence.

adding energization duty (it being constant value at time series) corresponding to the direct-current value for braking to the energization duty which acquires the alternating current wave for linear motor energization (it subtracting on parenchyma, if this energization duty is made into the negative value). this energization duty — large — /— by making it small, an in one direction flowed part corresponding to necessary damping force is obtained. An addition means performs such level (bias) adjustment or a setup by each electric coil correspondence. In this embodiment, the alternating current of the request amplitude for a flow drive, direct currents of the request level for braking, and those composition are performed by data processing of energization duty, and an electric coil energization circuit becomes very easy.

[0013] Other purposes and descriptions of this invention will become clearer than explanation of the example of the following which referred to the drawing.

[0014]

[Example] Arrangement of the magnetic pole and electric coil of one example of this invention is shown in drawing 1 . The inside 1 and 2 of drawing is the long side of continuous casting mold, 3 and 4 are shorter sides, and molten steel is poured into the space which these surround towards a background (it is from the upper part in a perpendicular direction z) through the impregnation nozzle 30 from the side front of the drawing 1 space. In this example, since the molten steel in mold (1-4) is driven from the right along a long side 1 on the left with a three-phase-circuit linear motor mold (in the direction of +y to -y), nine magnetic poles 11-19 of the 1st set arrange horizontally (the direction of +y to -y) on the outside of a long side 1. Moreover, since it drives from the left along a long side 2 on the right (- in the direction of y to +y), nine magnetic poles 21-29 of the 2nd set are arranged horizontally (the direction of +y to -y) on the outside of a long side 2. One electric coil 1Aa etc. is wound around these magnetic poles, respectively. The magnetic pole bases 10 and 20 which are the common magnetic paths between magnetic poles are connected in York 31 and 32 so that the leakage of the magnetic flux to those exteriors may be controlled.

[0015] Drawing 2 is referred to. the 1st of the 1st set wound around the 1st magnetic pole 11 of the 1st set — as shown in drawing 2 , electric coil 1Aa lets GTO411 for straight polarity energization (gate turnoff and SCR), and GTO412 for negative polarity energization pass, and is connected to + outgoing end and - outgoing end of DC power supply 60. ON (energization)/OFF (un-energizing) energization of GTO 411 and 412 is carried out by the GTO drivers 413 and 414, respectively. The current detector 415 detects the value (absolute value) of the current which flows to electric coil 1Aa, and the analog signal which shows it is given to the below-mentioned energization pulse generator 61. These energization and a detector element, and the combinational circuit of electric coil 1Aa are the 1st excitation circuit 41.

[0016] Other energization with same electric coil 1Ab etc. and detector elements are connected, and the same excitation circuit 42 grade is constituted. That is, about 9 per set [the] shown in drawing 1 , the 2nd set of nine electric coil 1Aa(s) etc., etc., as shown in drawing 2 , the 1st set of nine excitation circuits 41-49 and and the nine 2nd set excitation circuits 51-59 are constituted.

[0017] Drawing 3 is referred to. Drawing 3 shows the whole flow control circuit configuration including the excitation circuits 41-49 shown in drawing 2 , and 51-59. In addition, in drawing 3 , the power circuit was omitted and the arrow head showed the direction where a control signal flows. The energization pulse generators 61-69, and 71-79 give an ON instruction pulse (for high-level H, ON directions / low L is off directions) to the excitation circuits 41-49 and the GTO driver (411,412) of 51-59. The configuration of the energization pulse generator 61 is shown in drawing 4 . The function is mentioned later. Other energization pulse generator 62 grades are the same configurations as 61.

[0018] A function generator 81 gives a series of energization due teddy-TA which brings about alternating current sine wave (for example, Aa of drawing 7)-like change [time series current] to the energization pulse generators 61, 64, and 67 in the 1st set. A function generator 82 gives a series of energization due teddy-TA which brings about alternating current sine wave (for example, Ba of drawing 7)-like change [time series current] to the energization pulse generators 62, 65, and 68 in the 1st set. A function generator 83 gives a series of energization due teddy-TA which brings about alternating current sine wave (for example, calcium of drawing 7)-like change [time series current] to the energization pulse generators 63, 66, and 69 in the 1st set.

[0019] A function generator 84 gives a series of energization due teddy-TA which brings about alternating current sine wave (for example, Ab of drawing 7)-like change [time series current] to the energization pulse generators 71, 74, and 77 in the 2nd set. A function generator 85 gives a series of energization due teddy-TA which brings about alternating current sine wave (for example, Bb of drawing 7)-like change [time series current] to the energization pulse generators 72, 75, and 78 in the 2nd set. A function generator 86 gives a series of energization due teddy-TA which brings about alternating current sine wave (for example, Cb of drawing 7)-like change [time series current] to the energization pulse generators 73, 76, and 79 in the 2nd set.

[0020] The configuration of a function generator 81 is shown in drawing 5 . The function is mentioned later. Other function generators 82-86 are the same configurations as 81. The timing pulse for generating energization due teddy-TA of each ream so that alternating current sine wave (for example, Aa-calcium [of drawing 7], Ab-Cb)-like change [time series current] may be brought about etc. generates a timing signal, and gives a pulse generating circuit 90 to function generators 81-86.

[0021] With reference to drawing 6 , the pulse which a pulse generating circuit 90 generates is explained. When it is assumed as Is which shows the alternating current wave for a molten steel flow drive to drawing 6 , a pulse generating circuit 90 Generate the clock pulse Pd of a very short period to a round term of alternating current wave Is, and dividing of the clock pulse Pd is carried out. The energization timing pulse Pa which specifies a round term of duty energization of a short paddle period to a round term of Is too is generated, dividing of the pulse Pa is carried out and the 1st alternating current period synchronization pulse Pbo which specifies a round term of the alternating current current wave form Is is generated. A circuit 90 counts Pulse Pa on the basis of Pulse Pbo further. If Aa of drawing 7 R> 7 is matched with alternating current wave Is From it, 120 degrees, 240 degrees, 180 degrees, 60 degrees And the 2nd [for generating the wave Ba which was in about 300 degrees of phases, and calcium, Ab Bb and Cb (drawing 7)], 3rd, 4th, 5th, and 6th alternating current period synchronization pulses Pb120, Pb240, Pb180, Pb60, and Pb300 are generated. These pulses are given to function generators 81-86 and the energization pulse

generators 61-69, and 71-79 as shown in drawing 5 .

[0022] The function of a function generator 81 is explained with reference to drawing 5 . the criteria alternating current wave for a molten steel flow drive in memory 812 — Is (drawing 6) — energization due teddy-TA (it is resistance-welding-time data during a round term of Pulse Pa) for energizing a current to an electric coil the number of a clock pulse Pd — expressing, although Is is stored by 1 cycle and the absolute value of the value which energization due teddy-TA of a cycle expresses in the first half a cycle and the second half is the same in the first half, energization due teddy-TA of a cycle is made into a positive value, in order to specify straight polarity energization, and in the second half, in order to specify negative polarity energization, let energization due teddy-TA of a cycle be a negative value. The 1st alternating current period synchronization pulse Pbo (high-level H) clears an address counter 811, and the address counter 811 between low L counts [this pulse signal Pbo] up the energization timing pulse Pa (standup). KAUNTODE-TA of an address counter 811 specifies the read-out address of memory 812. thereby — memory 812 — arrival (standup of Pa) of Pulse Pa — synchronizing — a criteria alternating current wave — if a series of (a part for 1 cycle of Is) energization due teddy-TA for energizing Is to an electric coil is outputted one by one and Pulse Pbo comes, a series of same energization due teddy-TA will be outputted one by one again. The output data of memory 812 are latched to latch 813 synchronizing with Pulse Pa (falling) (storage).

[0023] Although the configuration of function generators 82-86 is the same as the configuration of 81 Since the 2nd alternating current period synchronization pulse Pb120 is given to a function generator 82 and the address counter (not shown) is cleared by this as shown in drawing 5 Since Pb120 is behind Pbo in about 120 degrees of phases, the electric coil energization current based on energization due teddy-TA which a function generator 81 generates Moreover, when [for example,] set to Aa of drawing 7 , The electric coil energization current based on energization due teddy-TA which a function generator 82 generates serves as Ba of drawing 7 . Since the 3rd alternating current period synchronization pulse Pb240 is given to a function generator 83 and the address counter (not shown) is cleared by this, and since Pb240 is behind Pbo in about 240 degrees of phases, the electric coil energization current based on energization due teddy-TA which a function generator 83 generates serves as calcium of drawing 7 . Aa (81 outputs) of a current (wave) which flows to an electric coil based on energization due TAIDE-TA which these function generators 81-83 output to electric coil 1Aa shown in drawing 1 , 2Aa, and 3Aa so that it may mention later in outline Since Ba (82 outputs) flows to electric coil 1Ba, 2Ba, and 3Ba and calcium (83 outputs) flows in electric coil 1calcium, 2calcium, and 3calcium, the field which moves to the left (-y) from the right (+y) along the long side 1 of mold by the magnetic poles 11-19 of the 1st set acts on the molten metal in mold.

[0024] Since the 4th alternating current period synchronization pulse Pb180 is given to a function generator 84 and the address counter (not shown) is cleared by this, and since Pb180 is behind Pbo in about 180 degrees of phases, when the electric coil energization current based on energization due teddy-TA which a function generator 81 generates serves as Aa of drawing 7 , the electric coil energization current based on energization due teddy-TA which a function generator 84 generates serves as Ab of drawing 7 . Since the 5th alternating current period synchronization pulse Pb60 is given to a function generator 85 and the address counter (not shown) is cleared by this, and since Pb60 is behind Pbo in about 60 degrees of phases, the electric coil energization current based on energization due teddy-TA which a function generator 85 generates serves as Bb of drawing 7 . Moreover, since the 6th alternating current period synchronization pulse Pb300 is given to a function generator 86 and the address counter (not shown) is cleared by this, and since Pb300 is behind Pbo in about 300 degrees of phases, the electric coil energization current based on energization due teddy-TA which a function generator 86 generates serves as Cb of drawing 7 . Bb is behind in about 120 degrees of phases to Cb, and notice Ab about the point which is behind in about 240 degrees of phases to Cb. Ab (84 outputs) of a current (wave) which flows to an electric coil based on energization due TAIDE-TA which these function generators 84-86 output to electric coil 4Ab shown in drawing 1 , 5Ab, and 6Ab so that it may mention later in outline Since Bb (85 outputs) flows to electric coil 4Bb, 5Bb, and 6Bb and Cb (86 outputs) flows to electric coil 4Cb, 5Cb, and 6Cb, the field which moves to the right (+y) from the left (-y) along the long side 2 of mold by the magnetic poles 21-29 of the 2nd set acts on the molten metal in mold.

[0025] The function of the energization pulse generator 61 is explained with reference to drawing 4 . The output data (Aa correspondence of drawing 7) of a function generator 81 are given to a multiplier 612. The drive current setter 611 gives amplification factor data to a multiplier 612. A setter 611 has an absolute encoder for an operator to specify an amplification factor. The output code which shows the numeric value of ****** and an encoder changes the tab of this encoder to the thing of angle-of-rotation correspondence. Amplification factors are zero or more values here. A multiplier 612 gives energization due teddy-TA which shows the value which carried out the multiplication of the data (amplification factor) which a setter 611 gives to the value which due teddy-TA which a function generator 81 gives expresses to an adder 614. For example, when the amplification factor which a setter 611 gives is 1, reference current Is (drawing 6) flows to electric coil 1Aa, but it will be set to Iaa shown in drawing 6 if an amplification factor is larger than 1. When an amplification factor is less than one, the current of a low flows from reference current Is to an electric coil.

[0026] The braking-current setter 613 other than energization due teddy-TA (the current value for a molten steel flow drive is specified) which carried out the multiplication of the above-mentioned amplification factor gives braking-current directions data to an adder 614. A setter 613 also has an absolute encoder for an operator to specify a braking current value (energization duty to determine). The output code which shows the numeric value of ****** and an encoder changes the tab of this encoder to the thing of angle-of-rotation correspondence. Braking current values are 0, a positive value, and a negative value, and when the tab of an encoder is a center valve position, if the data which express the positive value corresponding to an angle of rotation when an encoder rotates the data showing 0 clockwise from a center valve position are counterclockwise rotated from a center valve position, an absolute value will output the data showing the negative value of the value of angle-of-rotation correspondence to an adder 614 here. For example, at the time of the positive value (Ib of drawing 6 is specified) to which the data which a setter 613 gives exceed the braking current value 0, Iba which shows the current for a molten steel flow drive (for example, Iaa of drawing 6) to drawing 6 shifted in the forward direction by Ib flows to electric coil 1Aa. That is, an electric coil current becomes

what added the direct-current bias Ib for braking to the current Iaa for a molten steel flow drive. When the data which a setter 613 gives are a negative value, an electric coil current becomes what shifted the current Iaa for a molten steel flow drive in the negative direction.

[0027] When the polar distinction machine 615 detects forward [of the output data (value to express) of an adder 614], and negative polarity and they are detected with straight polarity, by high-level H, when it detects with negative polarity, the polar detecting signal of low L is given to AND gate 620,621, and the data in which the absolute value of the output data of an adder 614 is shown are given to an adder 616 and the feedback computing element 622. The feedback computing element 622 is the current value (absolute value.) which flowed to the electric coil from the current desired value (current value which the absolute value of the output data of an adder 614 shows) of an electric coil. The data in which the value which subtracted the output of the current detector 415 shown in <u>drawing 2</u> is shown are latched to latch 623 synchronizing with Pulse Pa (storage). Latch's 623 output data express the amount of amendments required in order to make into current desired value the current value which flows to an electric coil, when it is a positive value, they express the amount of necessary rises of an energization current value (energization duty), and they express the amount of necessary downs at the time of a negative value.

[0028] An adder 616 outputs the value which added the amount of amendments (latch's 623 output) to current desired value (absolute value of the output data of an adder 614) to a counter 617. In addition, when the amount of amendments which latch 623 gives is a negative value, an adder 616 will perform subtraction on parenchyma. The clock pulse Pd as a load indication signal is given to a counter 617 for the pulse which was delayed by the delay machine 618 and acquired Pulse Pa as a count pulse. A counter 617 When the pulse (load pulse) which was delayed and acquired Pulse Pa starts to high-level H, the output data of an adder 616 are loaded. If a load pulse falls, a clock pulse Pd will be counted, if counted value agrees in a load value (output data of an adder 616), a carry signal will be generated and a flip-flop 619 will be reset. In addition, a flip-flop 619 is set under ** of a load pulse, reverses the Q output from L to H, is reset by the carry signal, and returns Q output to L from H. Thereby, Q output of a flip-flop 619 starts synchronizing with Pulse Pa, and falls from this standup after progress of the time amount (the number of Pulses Pd) which the output data of an adder 616 show. In addition, although the output data of a function generator 81 switch synchronizing with Pulse Pa, since there are the processing times (time delay), such as an operation by the multiplier 612, the adder 614, the polar distinction machine 615, and the adder 616 and a judgment, about the data which switched, it is for waiting for completion of all operations, judgments, etc. to delay the load pulse from Pulse Pa.

[0029] Above-mentioned Q output of a flip-flop 619 is given to AND gates 620 and 621. Since a polar detecting signal (output of the distinction machine 615) is also given to these AND gates 620,621, this is inputted into AND gate 620 as it is and it is inputted [it is reversed and] into AND gate 621 When the output data of an adder 614 are what shows a positive value, AND gate 620 When said Q output is that with which between high-level H generates the energization indication signal Pdp of H, and the output data of an adder 614 indicate a negative value to be, said Q output generates [AND gate 621] the energization indication signal Ndp of H only for between high-level H. These signals Pdp and Ndp change by time series, as shown in <u>drawing 6</u> corresponding to change of the output data of a function generator 81, and they are given to the GTO drivers 413 and 414 of the excitation circuit 41 shown in <u>drawing 2</u>, respectively. Signal Pdp sets ~~considers~~ GTO411 only for during ~~between~~ H as a flow, and, thereby, as for the GTO driver 413, <u>only as for during ~~between~~ H, the forward direction current flows [Signal Pdp] to electric coil 1Aa. Signal Ndp sets ~~considers~~ GTO412 only for during ~~between~~ H as a flow,</u> and, thereby, as for the GTO driver 414, <u>only as for during ~~between~~ H, the forward direction current flows [Signal Ndp] to electric coil 1Aa</u>. By these, the energization current (time series smooth value) of electric coil 1Aa serves as Iba shown in <u>drawing 6</u>. The fluctuation between a forward peak and the negative peak of this current Iba is a molten steel flow drive current component which becomes settled with the output of a multiplier 612, and can adjust by the drive current setter 611, the level difference, i.e., the alternating current value, i.e., the molten steel driving force, between a forward peak / negative peak. The amount of [of Iba / Ib] direct-current bias is a braking current component which becomes settled with the output of the braking-current setter 613, and it can be adjusted by the braking-current setter 613. That is, damping force can be adjusted by the braking-current setter 613.

[0030] Other energization pulse generators 62-69, and 71-79 are the same configurations as the energization pulse generator 61 shown in above-mentioned <u>drawing 4</u>, and they operate similarly.

[0031] By the above configuration, to electric coil 1Aa shown in <u>drawing 1</u>, 2Aa, and 3Aa The current which adjusted the amplitude and direct-current bias of the current wave form Aa (81 outputs) shown in <u>drawing 7</u> for every electric coil flows. To electric coil 1Ba, 2Ba, and 3Ba The current which adjusted the amplitude and direct-current bias of the current wave form Ba (82 outputs) shown in <u>drawing 7</u> for every electric coil flows. In electric coil 1Ca ~~calcium,~~ 2Ca ~~calcium,~~ and 3Ca ~~calcium~~ Since the current which adjusted the amplitude and direct-current bias of the current wave form calcium (83 outputs) shown in <u>drawing 7</u> for every electric coil flows. By the magnetic poles 11-19 of the 1st set, the field which moves to the left (- y) from the right (+y) along the long side 1 of mold changes magnitude for every magnetic pole, and acts on the molten metal in mold, and, moreover, the braking field (quiescence field) from which magnitude differs for every magnetic pole acts on molten metal.

[0032] Similarly to electric coil 4Ab shown in <u>drawing 1</u>, 5Ab, and 6Ab To electric coil 4Bb which the current which adjusted the amplitude and direct-current bias of the current wave form Ab (84 outputs) shown in <u>drawing 7</u> for every electric coil flows, and is shown in <u>drawing 1</u>, 5Bb, and 6Bb To electric coil 4Cb which the current which adjusted the amplitude and direct-current bias of the current wave form Bb (85 outputs) shown in <u>drawing 7</u> for every electric coil flows, and is shown in <u>drawing 1</u>, 5Cb, and 6Cb Since the current which adjusted the amplitude and direct-current bias of the current wave form Cb (86 outputs) shown in <u>drawing 7</u> for every electric coil flows The field which moves to the right (+y) from the left (- y) along the long side 2 of mold by the magnetic poles 21-29 of the 2nd set changes magnitude for every magnetic pole, and acts on the molten metal in mold, and, moreover, <u>the braking field (quiescence field) from which magnitude differs for every magnetic pole acts on molten metal.</u>

[0033] This example goes to the left from the right along the long side 1 of the mold shown in <u>drawing 1</u> by above-mentioned shifting magnetic field and an above-mentioned braking field. Along with it, a long side 2 tends to be reached in a shorter side 4, it is going to go to the right from the left along a long side 2, and a rate tends to generate a uniform molten steel style as much

as possible in this flow direction that moreover goes the exterior of a nozzle 30 around along each side which reaches a long side 1 along with it in a shorter side 3. By the way, by the molten steel which flows into mold from a nozzle 30, a molten steel style as shown in (a) of drawing 8 and (b) by the continuous-line arrow head occurs. The velocity distribution in the magnetic pole 11 - the 19 array directions of long side 1 front face by this molten steel style becomes what is shown in (a) of drawing 9 as a continuous line by the profile, and a continuous line shows the velocity distribution in the magnetic pole 21 - the 29 array directions of long side 2 front face to (b) of drawing 9 by the profile.

[0034] The flow drive of the molten steel is carried out in the location in which the contamination of powder is controlled, and it becomes easy to rise [of the inclusion in molten steel] to surface, and molten steel tends (a rate is slow) to pile up by lowering the high rate of flow in about 30 nozzle of this molten steel style. By being horizontal and considering the molten steel style along the field of the mold side as whenever [constant direction and fixed-speed], the horizontal temperature distribution on the front face of coagulation of the molten steel by the field of the mold side become uniform, and generating of a blowhole is controlled. What is necessary is just to let the rate of flow of molten steel be constant value in each part of horizontal at drawing 9 R> 9, as an alternate long and short dash line shows in order to do in this way. As for a ****** field, the example shown in drawing 9 takes braking to the lower left, and takes a drive to a right going-down slash field. The necessary current value of each electric coil wound around each magnetic pole for filling this shows drawing 10 R> 0. In addition, (a) of drawing 9 shows that it is necessary to also pass a braking current in (a) of drawing 10 in addition to a drive current although a magnetic pole 19 (electric coil 3calcium) takes a drive. This braking current applies braking for controlling too much climax of the molten steel in the corner section of the long side 1 and shorter side 4 by the molten steel which flows on the left along a long side 1 colliding with a shorter side 4. (a) of drawing 9 shows that it is necessary to also pass a braking current in (a) of drawing 10 in addition to a drive current although a magnetic pole 11 (electric coil 1Aa) takes a drive. This braking current applies braking for controlling too much climax of the molten steel in the corner section of the long side 1 and shorter side 3 by the molten steel which goes to a long side 1 along with a shorter side 3 colliding with a shorter side 3.

[0035] The drive current (value shown with a right going-down slash bar graph) of each electric coil shown in drawing 10 is set up by the energization pulse generators 61-69 and the drive current setter (611) of 71-79, and sets up the braking current (value shown with a left going-down slash bar graph) of each electric coil by the energization pulse generators 61-69 and the braking-current setter (613) of 71-79. This becomes the velocity distribution shown in drawing 9 with an alternate long and short dash line by the profile, and molten steel flows in the location (height) of magnetic pole 11 grade in the direction shown in (b) of drawing 8 by the alternate long and short dash line arrow head, and it becomes the constant direction style of abbreviation constant speed at the surface latest of mold each sides 1-4.

[0036] In the above-mentioned example, due teddy-TA for forming a sine wave current with function generators 81-86 is generated. In addition, in the energization pulse generators 61-69, and 71-79 The multiplication of the amplification factor which the drive current setter 611 gives to energization due teddy-TA which a function generator gives is carried out. The duty for the direct-current bias which the braking-current setter 613 gives to the obtained product was added, to the obtained sum, further, the duty for deflection from the desired value by current feedback was added, and output data (energization duty) have been obtained. That is, output data are computed by digital data processing of energization due teddy-TA.

[0037] However, energization duty control may determine energization duty by other well-known arts conventionally. For example, it amplifies with the amplification factor (analog signal) to which a sine wave electrical potential difference is generated with function generators 81-86, and the drive current setter 611 outputs this sine wave electrical potential difference with adjustable gain amplifier. A part for the deflection from the direct-current bias value (analog signal) which the braking-current setter 613 outputs with an operational amplifier, and the desired value by current feedback (analog signal) is added to the output (carrying out bias of the output of an adjustable gain amplifier). A comparator compares the obtained sine wave electrical potential difference with the triangular wave (analog signal) of a predetermined period and predetermined level. When a sine wave electrical potential difference is higher than a triangular wave, turn ON GTO411 and GTO412 is turned OFF. When a sine wave electrical potential difference is lower than a triangular wave, the current Iba shown in drawing 6 as well as [for example,] an above-mentioned example can be passed to an electric coil by signal processing by the analog electrical circuit, such as turning OFF GTO411 and turning ON GTO412.

[0038] Furthermore, although electric coil 1Aa etc. is the form which goes magnetic pole 11 grade around, namely, the magnetic pole bases 10 and 20 are equipped in the above-mentioned example in the form which goes a straight line parallel to a x axis around, as shown in drawing 11 , you may equip with these electric coil 1Aa(s) etc. in the form which is a form which goes the management between magnetic poles of the magnetic pole bases 10 and 20 around, namely, goes a straight line parallel to the y-axis (drawing 1) around.

[0039]

[Effect of the Invention] To two or more electric coils (1Aa-3Aa, 1Ba-3Ba, 1calcium - 3calcium) for exciting each of two or more magnetic poles (11-19) which were arranged along the mold side (1) which encloses molten metal as above according to the flow control unit of this invention An alternating current energization means (611,612,615-621;41-49 of 81-83;61-69) The alternating current for a linear drive for carrying out the flow drive of the molten metal (Iaa:Aa, Ba, calcium) is energized in the array direction of a magnetic pole. And since a direct-current energization means (613,614,615-621;41-49 of 61-69) energizes a direct current for braking for braking molten metal (Ib), the flow drive of the molten metal is carried out by alternating current energization of an electric coil in the array direction of a magnetic pole, and it is braked by the galvanization. That is, the same electric coil is shared by a flow drive and braking. Therefore, flow of molten steel is ******(ed) by this flow drive, the blowhole of a molten steel coagulation front face can be removed, moreover, the rate of flow of impregnation molten steel can be controlled by braking, and surfacing of inclusion (for example, powder) can be made easy. Thus, the same electric coil can perform flow drive for control of a blowhole, or removal, and braking for control of the contamination of inclusion, and promotion of surfacing.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the drawing in which the array of the magnetic pole and electric coil of one example of this invention is shown, and the horizontal section of continuous casting mold is shown.
[Drawing 2] It is the block diagram showing the energization circuit connected to the electric coil shown in drawing 1 .
[Drawing 3] It is the block diagram showing the excitation circuits 41-49 shown in drawing 2 , and the energization control circuit which gives an energization signal to 51-59.
[Drawing 4] It is the block diagram showing the configuration of the energization pulse generator 61 shown in drawing 3 .
[Drawing 5] It is the block diagram showing the configuration of the function generator 81 shown in drawing 3 .
[Drawing 6] It is the timing diagram which shows the energization indication signal which the pulse which parts for 1 cycle Is (thing of a reference value), Iaa (what performed driving force amendment for every coil), and Iba (what performed driving force amendment and damping force amendment) of the time series smooth value of a current which flow to electric coil 1Aa shown in drawing 1 and drawing 2 , and the pulse generating circuit 90 shown in drawing 3 generate, and the energization pulse generator 61 shown in drawing 4 generate.
[Drawing 7] It is the timing diagram which shows the time series smooth value of the current which flows to an electric coil according to energization due teddy-TA which the function generators 81-86 shown in drawing 5 generate.
[Drawing 8] The vertical cross section of the mold (1-4) which shows (a) to drawing 1 , and (b) are horizontal sectional views.
[Drawing 9] The graph which shows the horizontal drift-velocity distribution of the molten steel in mold along long side 1 front face in the height of magnetic pole 11 grade by impregnation of the molten steel from the nozzle 30 to the mold (1-4) which shows (a) to drawing 1 , and (b) are graphs which show the horizontal drift-velocity distribution of the molten steel in mold along long side 2 front face.
[Drawing 10] The graph which shows the drive current and the braking current which are passed to electric coil 1Aa arranged on the background of a long side 1 required in order that (a) may make flush drift-velocity distribution shown in (a) of drawing 9 , and (b) are graphs which show the drive current and the braking current which are passed to electric coil 1Ab arranged on the background of a long side 2 required in order to make flush drift-velocity distribution shown in (b) of drawing 9 .
[Drawing 11] It is the drawing in which the array of the magnetic pole and electric coil of another example of this invention is shown, and (a) shows the horizontal section of continuous casting mold, and (b) is the side elevation of the direction of arrow-head B shown in (a).
[Description of Notations]
1: Long side of mold 2: Long side of mold
3: Shorter side of mold 4: Shorter side of mold
10: Magnetic pole base 11-19: Magnetic pole of the 1st set
1Aa: The electric coil wound around the magnetic pole 11
1Ba: The electric coil wound around the magnetic pole 12
1calcium: The electric coil wound around the magnetic pole 13
-
-
3calcium: The electric coil wound around the magnetic pole 19
20: Magnetic pole base 21-29: Magnetic pole of the 2nd set
4Ab(s): The electric coil wound around the magnetic pole 21
4Bb(s): The electric coil wound around the magnetic pole 22
4Cb(s): The electric coil wound around the magnetic pole 23
-
-
6Cb(s): The electric coil wound around the magnetic pole 29
30: Molten steel impregnation nozzle 31 32: York
41-49, 51-59: Excitation circuit
61-69, 71-79: Energization pulse generator

[Translation done.]